Chapter 3

Land and Water Resources in Poland: An Empirical Study

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3.1. Introduction

The use of land and water has gained increasing importance in public discourse in recent years. They are related to such wide-ranging topics as rapid urbanization, environmental issues, social policies, food supply, energy production, transportation networks, and national security. Historically, economic sciences have regarded land and water as important resources to be utilized in the process of economic development and one of the tenets of the classical theory of growth. As the sustainable development policies have rightfully gained increasing support, economists must re-examine and modernize their stance on the exploitation of one of the classical factors of production.

3.2. Methodology

This research aims to show how the use of land and water resources in Poland compares to other selected economies. It starts with a narrative literature review of related issues in economic research.

The main empirical part of the comparative analysis considers the following geographical areas: three largest European economies (Germany, France, and the United Kingdom), four Visegrad Group countries (Czech Republic, Hungary, Poland, and Slovakia), the world (average), and high-income countries (average). The separate comparative overview of the fishing industry is based on a different set of countries due to data availability.

For the final part of the study, Pearson's *r* correlation matrix and five ordinary least squares linear regression models are constructed. The dependent variable is the gross national income (GNI) per capita and 18 selected independent variables are relevant to the use of land and water resources. The models are based on cross-sectional data and their sample size depends on the regressors used (ranges from 82 to 149).

3.3. Literature review

Land and water resources are important drivers of economic growth. It is widely accepted that the destruction or misuse of these natural resources will harm future economic and social development [Górka, 2014]. The agricultural sector has traditionally been seen as one of the primary uses for the land. Farming in Poland is usually labour-intensive, characterized by relatively small individual fields, good quality of land, and pronounced differences and specializations between regions [Ziętara, 2008]. The status of land tenure is an important economic factor, as land tenants tend to have higher profitability and landowners tend to have higher productivity [Kagan, Ziętara, 2018]. Most of the agricultural land in Poland is obtained by its current private owners through family inheritance [Marks-Bielska, 2013]. There is an increasingly large quantity of agricultural land that is not used for agricultural production [Dzun, 2014]. The process slowed down temporarily after Poland joined the European Union but remains dangerous as it also affects fertile land [Dzun, 2012; Szymańska, 2015]. However, modern land use is diverse and with complicated implications, e.g. for housing, energy supply, industrial production, mining, tourism, environment, and quality of life [Górka, 2014].

The growth of cities has been one of the leading causes and effects of economic development over the past decades. While further urbanization might be seen as a requirement for further growth in many regions, the focus should be on its sustainability [Ochoa, Tan, Qian, Shen, Moreno, 2018; Wu, 2010]. There are many categories of cities in the literature, such as influential world cities [Alderson, Beckfield, 2004; Taylor, 2001], innovative smart cities [Eremia, Toma, Sanduleac, 2017; Szczech-Pietkiewicz, 2015], and enormous megacities [Cheeseman, de Gramont, 2017; Hall, Pain, 2006]. There can be a significant overlap between these categories. The geographic dispersion of economic activity is especially important considering the high impact of clusters on the regional development of Poland [Kowalski, 2010, 2013; Lis, Kowalski, Mackiewicz, 2021; Mackiewicz, 2019]. The reverse trend of migration from urban to rural areas, especially from the largest cities to their wider functional areas, is also present in Poland [Rosner, 2014; Źróbek-Różańska, Zysk, 2015].

Healthy ecosystems, including forests, rivers, and lakes, are crucial for mitigating the adverse impacts of climate change on the economy, such as extreme weather, destructive storms, droughts, disappearance of bees, and spread of tropical diseases

[Pierzgalski, 2008]. Poland has a large forest area, which provides it with timber used in various industries such as construction, furniture, pulp and paper, shipbuilding, and textiles. Wood and paper have also increased in importance as packaging materials due to their recyclability and the negative environmental implications of plastics. Extreme weather in Poland, resulting in heatwaves and droughts, is modelled to have a significant impact on agriculture in the future [Szwed et al., 2010].

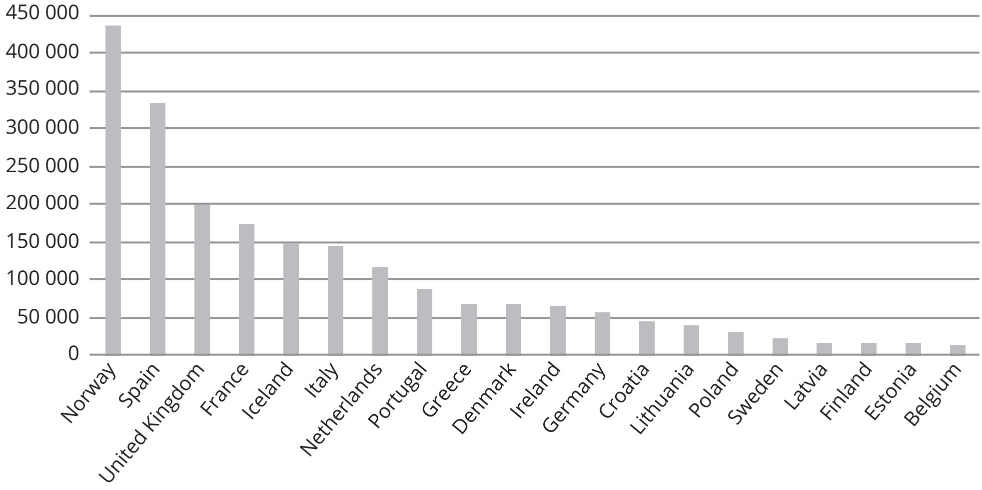
According to long-term forecasts, economic growth is the primary driver of water scarcity [Alcamo, Flörke, Märker, 2007; Distefano, Kelly, 2017]. The water resources of Poland are relatively limited compared to other European countries [Żurek, 2008]. Most water comes in the form of rainfall, which can lead to irregularities and droughts. Since the turn of the century, climate warming has led to a decrease in water resources in Poland [Ziernicka-Wojtaszek, 2015]. The ever-increasing complexity of water management is determined by this scarcity [Małecki, Gołębiak, 2012]. Variability of rainfall is a significant determinant of economic development [Brown, Lall, 2006]. As is the case with the use of land, agriculture plays a key part in the use of water [Mioduszewski, 2006]. Forests and green areas help regulate water resources and prevent floods [Pierzgalski, 2008].

The interest in renewable energy is currently at an all-time high. The Green New Deal, supported by both the European Union and the United States, places utmost importance on the use of environmentally conscious energy sources. The use of fossil fuels, especially coal, is a subject of vigorous debate in Poland. The pandemic has had a significant impact on crude oil prices [Nyga-Łukaszewska, Aruga, 2020]. Coal mining activities have a significant impact on landscape by causing pollution, and the loss of biodiversity and the necessary land reclamation projects take time and have high costs [Bian, Inyang, Daniels, Otto, Struthers, 2010; Hendrychová, Kabrna, 2016; Xiao, Hu, Fu, 2014]. Coal mining also causes damage to farmland in coal-cropland overlapping areas, which hurts the quantity and quality of agricultural production [Hu et al., 2014]. The drop in land efficiency caused by coal-related land destruction varies by region [Li, Chiu, Lin, 2019]. Importantly, Poland is relatively self-sufficient in meeting its coal needs [Nyga-Łukaszewska, Aruga, Stala-Szlugaj, 2020].

3.4. Fishing industry

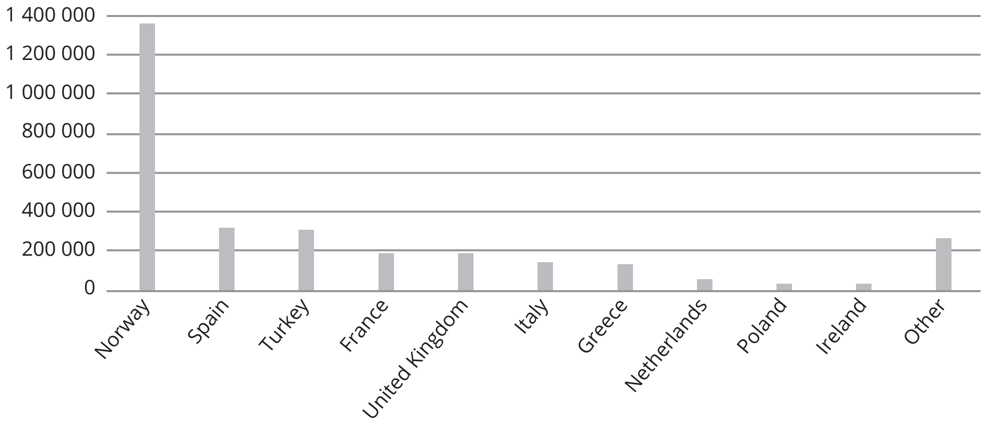
The bounty of the land and sea has sustained humanity since its earliest days. The European Union promotes sustainable development as a safeguard from the environmental destruction caused by unfettered exploitation of resources. With the focus on sustainability, overfishing is seen as a big problem. It seems important to look at which countries benefit from it the most. Figure 3.1 represents the fishing fleet size of European countries by gross tonnage. Norway takes first place with 437 thousand GT, followed by Spain (332 thousand), the United Kingdom (198 thousand), France (172 thousand), and Iceland (149 thousand). Clearly, the size of the fishing fleet in Europe is determined by access to the Atlantic Ocean. Poland is ranked 15th with 32 thousand GT. Notably, it overtakes the Scandinavian countries of Sweden (23 thousand) and Finland (16 thousand).

Figure 3.1. Fishing fleet size in 2019 (gross tonnage)



Source: Eurostat [2021].

Figure 3.2. Aquaculture production in 2018 (tonnes live weight, excludes hatcheries and nurseries)



Source: Eurostat [2021].

Figure 3.2 shows the size of aquaculture production. OECD [2021] defines aquaculture as "the farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants. Farming implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators and so forth. It also implies individual or corporate ownership of the stock being cultivated". In other words, aquaculture has more in common with raising livestock than with hunting. Norway is again ranked first but this time the gap is much larger (1.36 million for Norway and 319 thousand for Spain). Poland is ranked ninth with 37 thousand, which places it ahead of Denmark (11th, 32 thousand), Germany (12th, 32 thousand), and Iceland (16th, 19 thousand).

3.5. Comparative analysis

Table 3.1 shows the variables chosen for the comparative analysis and linear regression model. The regressors are grouped into four categories: "Population and urbanization" (three variables), "Agriculture" (five variables), "Environment and water" (five variables), and "Energy and natural resources" (five variables). The table also gives the unit and date (most recent available). Table 3.2 provides the values for the selected geographical areas: three largest European economies, four Visegrad Group countries, the world (average), and high-income countries (average).

Out of the selected countries, Poland has the lowest GNI per capita (USD 15,350) and penultimate degree of urbanization (60%). Poland's degree of urbanization is significantly behind high-income countries (81%), and only higher than Slovakia's (54%). Population density is the highest in the United Kingdom (275) and Germany (237) – other countries, including Poland and France, have around half of their values. The percentage of the urban population living in the largest city is, somewhat surprisingly, by far the lowest in Germany (6%) and Poland (8%).

When it comes to the use of land for agriculture, all the countries are somewhat even, except the United Kingdom, which simultaneously has the highest percentage of agricultural land (72%) and the lowest percentage of arable land (25%). Worryingly, Poland has, by far, the lowest agricultural productivity per worker: USD 6,870, compared to Slovakia's USD 41,082 and France's USD 51,257. The cause of this might be very high agricultural employment in Poland (10.6%).

Forest cover is the highest in Slovakia (40.4%), but Poland (30.9%) is still slightly above the world average (30.7%). Terrestrial protected areas in Poland represent 39.7% of total land while marine protected areas constitute 22.6% of territorial waters. The latter figure is much lower than in Germany (45.4%). When it comes to annual freshwater withdrawals, Poland's 21.4% of internal resources pale in comparison to Hungary's 84.2%. Annual carbon emissions per capita are on average highest in high-income countries (10.8). Considering Visegrad Group countries, Poland (7.5) pollutes more than Hungary (4.2) and Slovakia (5.7) but less than the Czech Republic (9.2).

Table 3.1. Variables

Variable	Category	Definition	Unit	Date
GNI	economic development	gross national income per capita, Atlas method	USD	2019
POP1	population and urbanization	urban population	% of total population	2018
POP2	population and urbanization	population density	people per sq. km	2019
POP3	population and urbanization	population in the largest city	% of urban population	2018
AGR1	agriculture	land use: arable land	% of land area	2018
AGR2	agriculture	agricultural land	% of land area	2014–2016
AGR3	agriculture	fertilizer consumption	kilograms per hectare of arable land	2014–2016
AGR4	agriculture	agricultural employment	% of total employment	2014–2016
AGR5	agriculture	agricultural productivity: value added per worker	2010 USD	2016
ENV1	environment and water	land use: forest area	% of land area	2018
ENV2	environment and water	terrestrial protected areas	% of total land area	2017
ENV3	environment and water	marine protected areas	% of territorial waters	2017
ENV4	environment and water	annual freshwater withdrawals	% of internal resources	2014
ENV5	environment and water	carbon dioxide emissions: per capita	metric tonnes	2014
ENE1	energy and natural resources	energy use per capita	kilograms of oil equivalent	2014
ENE2	energy and natural resources	sources of electricity production: coal	% of total	2015
ENE3	energy and natural resources	sources of electricity production: renewable sources	% of total	2015
ENE4	energy and natural resources	sources of electricity production: nuclear power	% of total	2015
ENE5	energy and natural resources	total natural resources rents	% of GDP	2016

Source: World Bank [2021a, 2021b].

The comparison of sources of electricity reveals stark differences. For nuclear power, Poland (0%) is last while France (77.6%) leads the way. In fact, Poland is the only country in the comparison without any nuclear power, with Slovakia (56.9%) and Hungary (52.2%) generating more than half from this source. The use of coal is still widespread, and Poland (80.9%) is by far the most dependent on it, followed by the Czech Republic (53.1%) and Germany (44.3%). France (2.2%) has successfully limited its use of coal. On the other hand, Poland's (12.7%) energy from renewable sources is remarkably good, trailing only Germany (26.3%) and the United Kingdom (23%). Poland (0.8%) has relatively high rents from natural resources, compared to France's 0%, Germany's 0.1%, and the Czech Republic's 0.3%. This indicates that Poland still places a relatively high priority on the exploitation of its natural resources, primarily coal. Moderate efforts to push out fossil fuels focus on renewable energy instead of nuclear power.

Table 3.2. Values

Variable	World	High income	Germany	France	United Kingdom	Czech Republic	Hungary	Slovakia	Poland
GNI	11 571.0	45 354.0	48 580.0	42 450.0	42 220.0	21 940.0	16 500.0	19 210.0	15 350.0
POP1	55.0	81.0	77.0	80.0	83.0	74.0	71.0	54.0	60.0
POP2	58.0	35.0	237.0	122.0	275.0	138.0	107.0	113.0	124.0
POP3	16.0	19.0	6.0	20.0	16.0	16.0	25.0	15.0	8.0
AGR1	11.1	10.3	33.7	33.5	24.9	32.3	47.8	28.0	35.3
AGR2	37.0	35.0	48.0	52.0	72.0	45.0	58.0	39.0	47.0
AGR3	140.6	136.6	197.2	163.1	252.9	196.1	128.3	125.8	172.8
AGR4	28.3	3.3	1.3	2.9	1.1	2.9	5.0	2.9	10.6
AGR5	3351.0	34 171.0	47 249.0	51 257.0	47 672.0	24 996.0	24 078.0	41 082.0	6870.0
ENV1	30.7	29.0	32.7	31.2	13.1	34.6	22.9	40.4	30.9
ENV2	14.7	15.1	37.8	25.8	28.7	22.2	22.6	37.6	39.7
ENV3	11.4	23.2	45.4	45.0	28.9	n/a	n/a	n/a	22.6
ENV4	n/a	n/a	30.8	14.9	5.5	12.5	84.2	4.4	21.4
ENV5	4.7	10.8	8.9	4.6	6.5	9.2	4.2	5.7	7.5
ENE1	1922.0	4677.0	3779.0	3659.0	2777.0	3915.0	2314.0	2943.0	2473.0
ENE2	39.2	28.6	44.3	2.2	22.8	53.1	19.5	12.5	80.9
ENE3	6.8	9.6	26.3	6.2	23.0	9.2	9.8	8.2	12.7
ENE4	8.1	17.1	14.3	77.6	20.9	32.5	52.2	56.9	0.0
ENE5	1.7	1.0	0.1	0.0	0.3	0.3	0.2	0.3	0.8

Source: World Bank [2021a, 2021b].

3.6. Linear regression model

Five linear regression models (ordinary least squares) are proposed based on cross-sectional data. GNI is the dependent variable in all models. Models 1–4 include only regressors from individual categories. Model 5 includes 17 regressors. Table 3.3 provides a correlation matrix for the variables. Of particular interest is the first column showing which variables are positively or negatively associated with GNI per capita. The strongest positive correlation is noted for energy use per capita (ENE1, 0.611), urbanization (POP1, 0.580), and carbon emissions per capita (ENV5, 0.498). On the other hand, agricultural employment (AGR4, −0.615) is the only strong negative correlation. Table 3.4 shows a summary of the models. All of them are statistically significant at a 0.1% level. Model 5 has lower degrees of freedom (*df*) because of more regressors and a smaller sample size. Model 5 also has the highest adjusted R^2 (0.552) and the lowest error.

Table 3.5. includes the coefficient for all the models. Model 1 includes only variables related to urbanization. Urbanization (POP1) and population density (POP2) are statistically significant at a 0.1% level and the population of the largest city (POP3) is statistically significant at a 5% level. POP1 and POP2 have positive coefficients, while POP3 has a negative coefficient. Urbanization (POP1) has the highest impact on GNI with a standardized coefficient of 0.554.

Model 2 considers agriculture variables. Only two variables are statistically significant: fertilizer consumption (AGR3) at a 5% level and agricultural employment (AGR4) at a 0.1% level. The former has a modest positive impact on GNI, and the latter has a strong negative impact with a standardized coefficient of −0.571.

Model 3 comprises the impact of the environment and water resources. As is the case with the previous model, there are two statistically significant variables: marine protected areas (ENV3, 1% level) and carbon emissions per capita (ENV5, 0.1% level). Both have a positive association with GNI, but the standardized coefficient of carbon emissions per capita is the highest (0.509).

Model 4 is related to energy production and the exploitation of natural resources. The only variable not statistically significant is the use of coal (ENE2). Nuclear power (ENE4) and total rents (ENE5) are significant at a 5% level while energy use per capita (ENE1) and renewable energy (ENE3) are significant at a 0.1% level. Energy use per capita has a strong positive impact on GNI with a standardized coefficient of 0.612.

Model 5 includes all the variables but one. The proxies for economic activity per capita (ENV5 and ENE1) cannot be in the same model because there is very high multicollinearity between them as measured by the variance inflation factor (VIF).

Table 3.3. Pearson's *r* correlation matrix

	GNI	POP1	POP2	POP3	AGR1	AGR2	AGR3	AGR4	AGR5	ENV1	ENV2	ENV3	ENV4	ENV5	ENE1	ENE2	ENE3	ENE4	ENE5
GNI	–																		
POP1	0.580	–																	
POP2	0.310	0.210	–																
POP3	0.039	0.076	0.464	–															
AGR1	−0.033	−0.171	−0.012	−0.246	–														
AGR2	−0.230	−0.174	−0.156	−0.136	0.567	–													
AGR3	0.233	0.207	0.743	0.367	−0.126	−0.188	–												
AGR4	−0.615	−0.749	−0.156	0.047	0.071	0.204	−0.146	–											
AGR5	0.179	0.238	0.000	−0.015	−0.018	0.003	0.016	−0.216	–										
ENV1	−0.052	−0.012	−0.127	0.048	−0.249	−0.420	−0.049	0.026	−0.071	–									
ENV2	0.123	0.127	−0.011	−0.002	−0.056	−0.161	−0.067	−0.086	−0.025	0.316	–								
ENV3	0.245	0.268	−0.080	−0.264	0.058	0.017	−0.048	−0.326	0.047	0.134	0.352	–							
ENV4	0.003	0.081	0.375	0.092	−0.164	−0.156	0.199	−0.088	−0.026	−0.252	−0.157	−0.069	–						
ENV5	0.498	0.517	0.037	−0.008	−0.190	−0.274	0.204	−0.537	0.089	−0.108	0.051	0.114	0.306	–					
ENE1	0.611	0.511	0.077	0.052	−0.234	−0.349	0.193	−0.528	0.105	−0.088	0.019	0.051	0.237	0.877	–				
ENE2	−0.008	−0.038	0.056	−0.147	0.137	0.200	−0.054	−0.103	−0.058	−0.013	0.070	0.157	−0.154	0.031	−0.074	–			
ENE3	0.355	0.189	−0.071	−0.126	0.245	0.170	−0.052	−0.248	0.022	−0.022	0.210	0.196	−0.157	−0.063	0.061	−0.023	–		
ENE4	0.275	0.177	−0.052	−0.255	0.291	0.062	−0.050	−0.287	0.063	0.117	0.159	0.470	−0.090	0.049	0.128	0.034	0.063	–	
ENE5	−0.270	−0.190	−0.116	0.160	−0.222	−0.077	−0.052	0.372	−0.102	0.020	−0.114	−0.173	0.056	0.028	0.061	−0.175	−0.334	−0.223	–

Source: Compiled by author.

They are both statistically significant if included in the model, but the model with ENE1 has a slightly higher adjusted R^2 (0.552 compared to 0.524). As such, the final model includes energy use per capita (ENE1) and not carbon emissions per capita (ENV5). Furthermore, because of the data availability requirements for all 17 regressors, the model has the lowest sample size at 82. Model 5 has two statistically significant regressors: energy use per capita (ENE1) at 0.1% level and renewable energy (ENE3) at 1% level. Other regressors lose their significance, which includes both urbanization (POP1) and agricultural employment (AGR4). ENE1's standardized coefficient is 0.486 (a significant drop compared to 0.612 in Model 4) and ENE3's is 0.250 (a slight drop from 0.255).

Table 3.4. Model summary

H	*R*	R^2	Adjusted R^2	RMSE	*N*	ANOVA		
						df (residual)	*F*	*p*
Model 1 – Population and urbanization								
H_0	0	0	0	19 777				
H_1	0.664	0.441	0.429	14 938	146	142	37.378	<.001
Model 2 – Agriculture								
H_0	0	0	0	19 995				
H_1	0.650	0.423	0.402	15 458	149	143	20.926	<.001
Model 3 – Environment and water								
H_0	0	0	0	19 204				
H_1	0.614	0.377	0.345	15 538	106	100	12.080	<.001
Model 4 – Energy and natural resources								
H_0	0	0	0	20 514				
H_1	0.745	0.555	0.537	13 952	134	128	31.905	<.001
Model 5 – Large model								
H_0	0	0	0	20 083				
H_1	0.804	0.646	0.552	13 439	82	64	6.876	<.001

Source: Compiled by author.

We can see that the inclusion of energy and natural resources variables in the largest model dwarfs the importance of other variables. The fact that no model shows the statistical significance of the use of coal is important, considering Poland's energy policy and aspirations. Model 2 reveals a strong negative impact of agricultural employment on GNI per capita, which is worrying because Poland's (10.6%) is very high compared to advanced European economies. Excluding the proxies for economic activity per capita, Model 5 shows that renewable energy is the most significant driver of development. Crucially, while Poland lags behind high-income countries in many categories, it overtakes them in this one (12.7% compared to 9.6%). The reason for that is most probably the fear of nuclear power that has traditionally been strong in Polish society. Still, the result is that Poland ranks high with regard to one of the most important aspects of development.

Table 3.5. Model coefficients

Model		Unstandardized	Standard error	Standardized	*t*	*p*	95% CI		Collinearity statistics	
							Lower	Upper	Tolerance	VIF
Model 1 – Population and urbanization										
H_0	(Intercept)	14 599.795	1636.729		8.920	<.001	11 364.865	17 834.724		
H_1	(Intercept)	−11 490.870	4440.916		−2.587	0.011	−20 269.723	−2712.018		
	POP1	489.369	57.033	0.554	8.580	<.001	376.626	602.113	0.944	1.059
	POP2	3.262	0.797	0.298	4.094	<.001	1.687	4.837	0.745	1.342
	POP3	−150.470	75.784	−0.141	−1.986	0.049	−300.281	−0.660	0.783	1.277
Model 2 – Agriculture										
H_0	(Intercept)	15 894.295	1638.060		9.703	<.001	12 657.288	19 131.302		
H_1	(Intercept)	29 762.938	2916.350		10.206	<.001	23 998.211	35 527.665		
	AGR1	90.900	109.977	0.065	0.827	0.410	−126.490	308.290	0.654	1.529
	AGR2	−96.405	75.398	−0.104	−1.279	0.203	−245.442	52.633	0.613	1.632
	AGR3	1.251	0.514	0.159	2.435	0.016	0.235	2.266	0.950	1.053
	AGR4	−528.712	62.483	−0.571	−8.462	<.001	−652.221	−405.202	0.886	1.129
	AGR5	0.009	0.012	0.046	0.706	0.481	−0.016	0.033	0.949	1.054
Model 3 – Environment and water										
H_0	(Intercept)	17 541.698	18 65.257		9.404	<.001	13 843.237	21 240.159		
H_1	(Intercept)	5501.286	3545.145		1.552	0.124	−1532.181	12 534.753		
	ENV1	−54.727	71.714	−0.066	−0.763	0.447	−197.006	87.553	0.827	1.209
	ENV2	186.689	170.934	0.103	1.092	0.277	−152.440	525.817	0.696	1.437
	ENV3	339.359	118.940	0.259	2.853	0.005	103.385	575.332	0.757	1.321
	ENV4	−3.774	2.215	−0.147	−1.704	0.091	−8.168	0.620	0.841	1.189
	ENV5	1455.636	242.02	0.509	6.015	<.001	975.475	1935.797	0.871	1.149
Model 4 – Energy and natural resources										
H_0	(Intercept)	17 168.284	1772.111		9.688	<.001	13 663.116	20 673.451		
H_1	(Intercept)	4024.699	2437.102		1.651	0.101	−797.523	8846.921		
	ENE1	4.179	0.411	0.612	10.165	<.001	3.366	4.993	0.959	1.043

Model		Unstandardized	Standard error	Standardized	*t*	*p*	95% CI		Collinearity statistics	
							Lower	Upper	Tolerance	VIF
	ENE2	8.140	48.427	0.010	0.168	0.867	−87.680	103.961	0.959	1.043
	ENE3	470.768	116.462	0.255	4.042	<.001	240.328	701.209	0.874	1.144
	ENE4	222.366	94.201	0.145	2.361	0.020	35.973	408.759	0.928	1.078
	ENE5	−463.63	187.789	−0.162	−2.469	0.015	−835.203	−92.056	0.804	1.244
Model 5 – Large model										
H_0	(Intercept)	18 923.78	2217.754		8.533	<.001	14 511.146	23 336.415		
H_1	(Intercept)	1433.358	14 804.378		0.097	0.923	−28 141.787	31 008.502		
	POP1	222.585	150.419	0.206	1.480	0.144	−77.912	523.082	0.286	3.491
	POP2	−1.306	8.242	−0.018	−0.158	0.875	−17.771	15.160	0.430	2.324
	POP3	−99.453	142.256	−0.067	−0.699	0.487	−383.641	184.736	0.604	1.655
	AGR1	11.714	165.737	0.008	0.071	0.944	−319.384	342.812	0.403	2.482
	AGR2	−131.149	108.252	−0.137	−1.212	0.230	−347.406	85.108	0.430	2.327
	AGR3	−0.177	2.589	−0.007	−0.068	0.946	−5.349	4.996	0.529	1.890
	AGR4	−79.654	206.586	−0.062	−0.386	0.701	−492.356	333.049	0.215	4.661
	AGR5	0.004	0.011	0.025	0.308	0.759	−0.019	0.026	0.852	1.174
	ENV1	−37.456	104.958	−0.040	−0.357	0.722	−247.133	172.221	0.450	2.221
	ENV2	−70.370	192.518	−0.035	−0.366	0.716	−454.969	314.229	0.615	1.626
	ENV3	216.198	156.679	0.135	1.380	0.172	−96.805	529.201	0.580	1.725
	ENV4	−2.316	2.742	−0.094	−0.845	0.402	−7.793	3.162	0.443	2.259
	ENE1	3.255	0.907	0.486	3.588	<.001	1.443	5.068	0.301	3.323
	ENE2	48.160	78.787	0.056	0.611	0.543	−109.234	205.555	0.650	1.538
	ENE3	399.205	144.634	0.250	2.760	0.008	110.265	688.146	0.671	1.490
	ENE4	79.518	148.318	0.052	0.536	0.594	−216.781	375.817	0.583	1.716
	ENE5	−554.424	395.243	−0.151	−1.403	0.166	−1344.013	235.165	0.475	2.104

Source: Compiled by author.

3.7. Conclusions

The exploitation of land and water resources is related to many important issues facing modern economies, including urbanization, agriculture, and energy production. Together with labour and capital, they form the three factors of production central to the classical theory of economic growth.

Based on the literature review, the empirical analysis examines economic development (dependent variable) and 18 regressors related to land and water resources grouped into four categories: “population and urbanization”, “agriculture”, “environment and water”, and “energy and natural resources”. The comparative analysis focuses mostly on the three largest European economies, four Visegrad Group countries, the world average, and high-income countries average.

Poland still assigns a high priority to the exploitation of coal. Moderate efforts to push out fossil fuels focus on renewable energy instead of nuclear power, as Poland is the only country in the comparison with no nuclear energy produced. Other variables where Poland ranks relatively low are GNI per capita, urbanization, and agricultural productivity. The last one is especially important considering the high level of employment in the sector. Despite its widespread use of coal, Poland has lower carbon emissions than the average for high-income countries. The population of Warsaw constitutes a small percentage of the total urban population compared to other countries (excluding Germany), which is somewhat surprising given the city’s role in the national economy. The forest cover in Poland is above the world average. Poland’s position concerning aquaculture production is relatively strong, while its fishing fleet is about average.

Pearson’s *r* correlation matrix reveals that energy use per capita, urbanization, and carbon emissions per capita have a strong positive correlation with GNI per capita. On the other hand, agricultural employment has a strong negative correlation. Models 1–4 show a statistically significant positive impact of urbanization, population density, fertilizer consumption, marine protected areas, carbon emissions per capita, nuclear power, energy use per capita, and renewable energy. Models 1–4 also show a statistically significant negative impact of agricultural employment, urban population of the largest city, and total rents from natural resources. Model 5 has the most regressors and the highest adjusted R^2. Only two regressors used in this model show statistical significance: energy use per capita and renewable energy. They both have positive coefficients. Considering Poland’s energy policy, it is important to note that no model shows the statistical significance of the use of coal.

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